§30. Mechanical Property Stability of 9Cr-Oxide Dispersion Strengthened (ODS) Steel during the Long-term Thermal Aging at High Temperature

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Introduction

Oxide dispersion strengthened (ODS) steels are the promising fusion blanket structural materials for use up to about 650-700℃ because of the excellent creep strength and good irradiation resistance.[1,2] During the operation, the stability of mechanical properties and microstructure should be stable as possible. Thus, the aging experiments are carried out to understand the fundamental stability behavior during long-term thermal aging for the ODS steels.

Experimental

The material used is the 9Cr-ODS steel with a chemical composition of Fe-9.08wt%Cr-1.97%W-0.14C%-0.29%Y-0.23Ti%-0.16O. The steel was normalized at 1050℃ for 1 hour and then tempered at 800℃ for 1 hour. The annealing experiments were carried out at 700℃ from 100 h up to 10000 h.

After aging treatments, the hardness was measured by Vickers hardness and nano-indentation testing machines. Tensile properties were tested at room temperature and 700℃ with an initial strain rate of $6.67\times10^{-4}s^{-1}$ in a vacuum of about 1.0×10^{-6}Torr.

Results

The hardness results are shown in Fig.1. The hardness results showed that after aging at 700℃, both nano-indentation hardness (Hn) and Vickers hardness (HV) decreased slightly with the increasing of aging time from 100 h up to 1000 h, suggesting slight softening.

Figs. 2 and 3 show the variation of tensile properties with the aging time for 9Cr-ODS steel tested at RT and 700℃, respectively. After aging at 700℃ for 100 up to 10000 h, the ultimate tensile strength (UTS), yield strength (YS) and total elongation (TE) of 9Cr-ODS steel did not change significantly tested at both RT and 700℃, suggesting the almost stability of mechanical property by aging.

Conclusion:

The aging experiments for 9Cr-ODS steel were carried out at 700℃ from 100 up to 10000 h. After aging, the hardness decreased slight with the increasing of aging time. On the contrary, the tensile properties did not change significantly by aging up to 10000 h. The present results suggested a good stability of mechanical properties of 9Cr-ODS steel comparing to our previous study in reduced activation ferritic/martensitic steels (RAFMs) such as CLAM and JLF-1 steels [3].

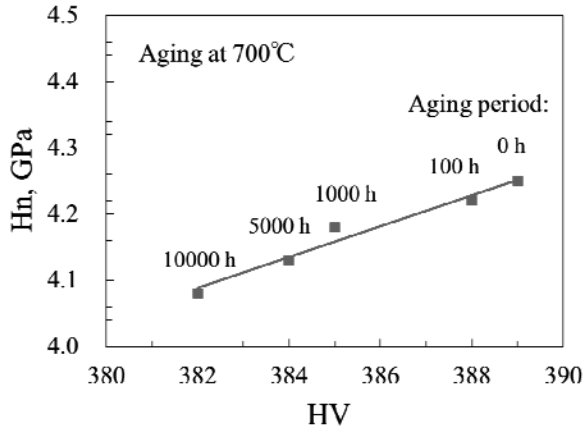

Fig.1 Variation of Hn and HV with aging time at 700℃ in 9Cr-ODS steel. (RT)

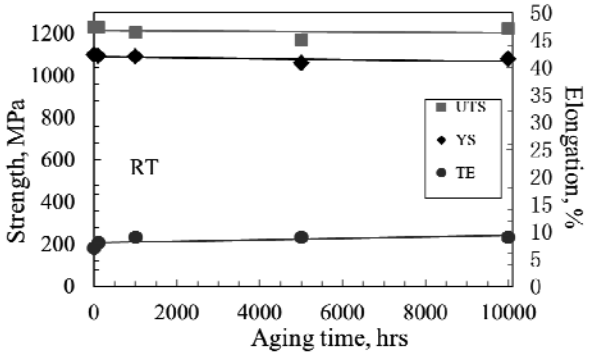

Fig.2 Variation of tensile properties with aging time at 700℃ in 9Cr-ODS steel tested at RT.

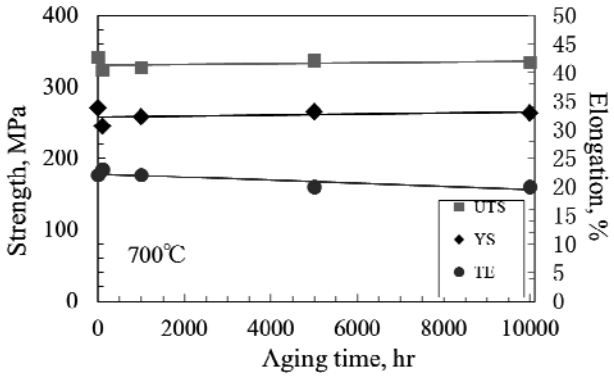

Fig.3 Variation of tensile properties with aging time at 700℃ in 9Cr-ODS steel tested at RT.

1) Ukai, S. et al.: ISIJ International. **43** (2003) 2038.
2) Li, Y.F, et al.: Fusion Eng. Des. **86** (2011) 2495.
3) Li, Y.F, et al.: Plasma & Fus. Res.**5** (2010) S1036.